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PEP Computation of Dew Point Temperature at Mandatory Levels

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The available data are relative humidity (RH) values in each of the lowest three σ layers of the PEP model.

The procedure is to interpolate (or extrapolate) RH linearly with π $\left(\pi = (p/1000)^{R/C_p}\right)$ from the center of each layer to the mandatory levels. 400 mb is the highest mandatory level included. This interpolation is parallel to that performed for the other forecast parameters. If after the interpolation, the mandatory level value of RH is found to exceed the limits of 10% to 100%, it is given the limiting value at that point.

At the mandatory level, to which temperature has already been interpolated, Teten's formula for saturation vapor pressure, e_s, (in mb's)

$$e_s = 6.1078 \exp\left[17.269\, T/(T + 237.3)\right] \qquad (1)$$

(T in degrees C) is combined with the definition of relative humidity

$$RH = e/e_s \qquad (2)$$

to solve for e the ambient vapor pressure. The ambient vapor pressure is then used in Teten's formula to solve for the dewpoint temperature

$$T_D = 237.3\ \frac{C}{17.269 - C} \qquad (3)$$

where

$$C = \ln(e) - 1.8096$$

In the actual machine program, the formulae (1), (2) and (3) are combined into one in order to avoid computing both the exponential in (1) and the logarithm in (3).

To wit:

$$RH = \frac{e}{e_s} = \exp\left[\frac{17.269\ T_D}{T_D + 237.3} - \frac{17.269\ T}{T + 237.3}\right]$$

taking the log and solving for T_D gives

$$T_D = \frac{-237.3 * (A + 1)T - (237.3)^2 A}{A * T + 237.3\ (A - 1)}$$

$$A = \ln (RH) / 17.269$$